

# Prototyping the Emergency Smoke Response System (ESRS)

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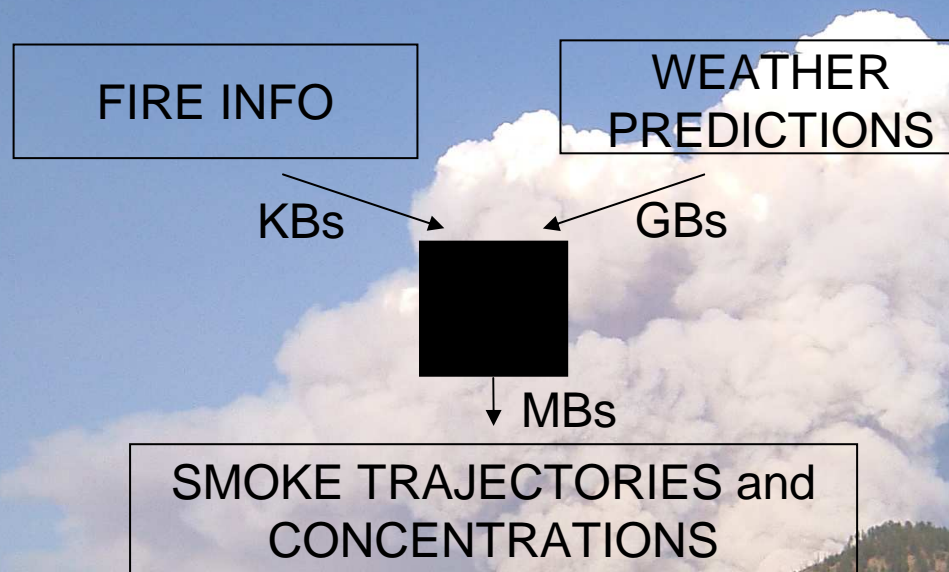
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Pete Lahm (USFS), Trent Procter, Suraj Ahuja (USFS Region 5)

CARPA  
October 16, 2008



# Smoke Modeling



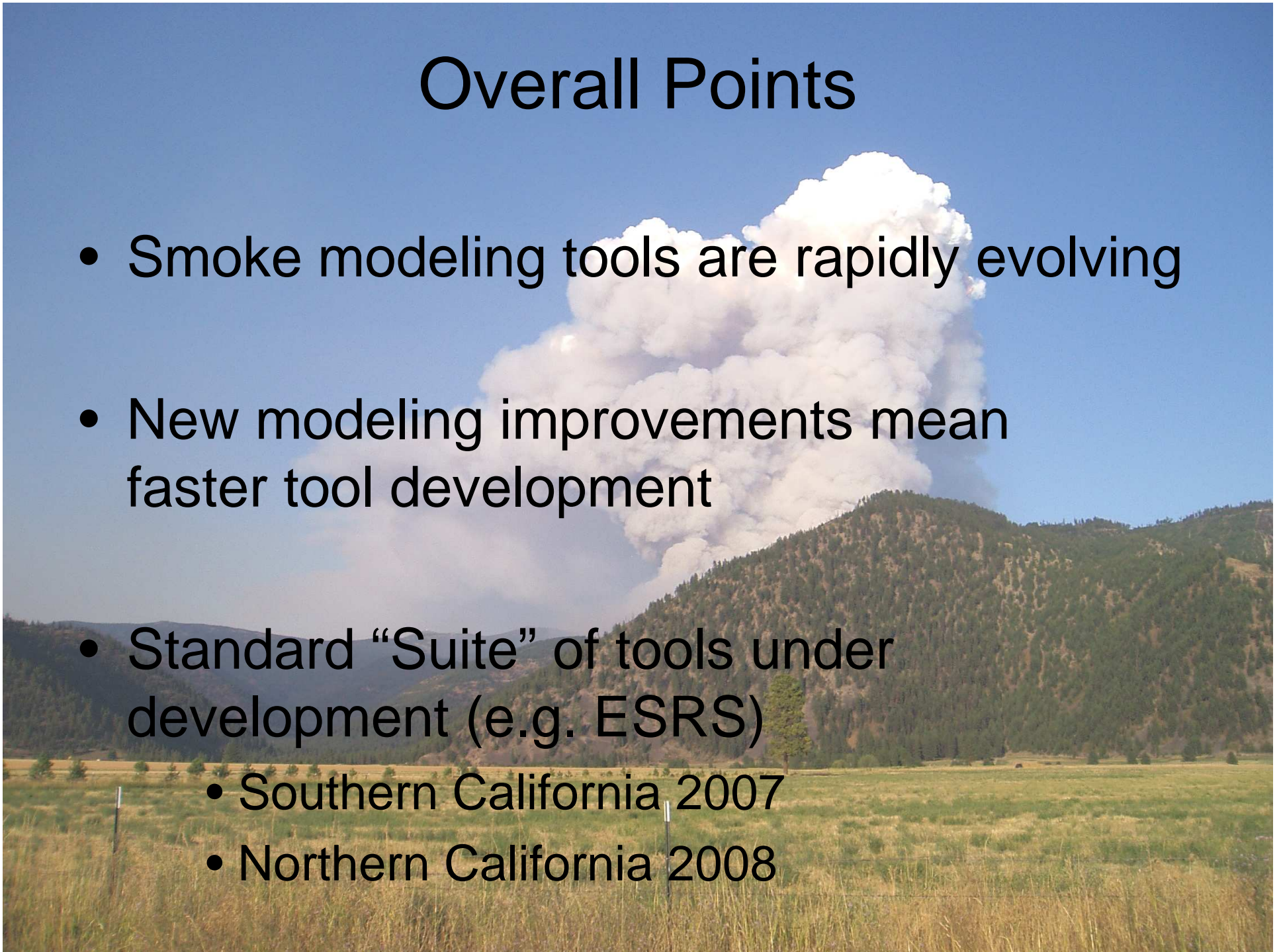
- Scale: kilometers to 100's of km; days
- Multiple, ill-defined sources across a wide region
- Real-time forecasts as well as after-action

Generally: 3-D Met models; PM (+chemistry);  
server-run; web-delivered



# Overall Points

- Smoke modeling tools are rapidly evolving
- New modeling improvements mean faster tool development
- Standard “Suite” of tools under development (e.g. ESRS)
  - Southern California 2007
  - Northern California 2008



# Smoke is a growing issue

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More fire

*Increasing wildfires, WFU and Rx fires*

Decreased public acceptance of smoke

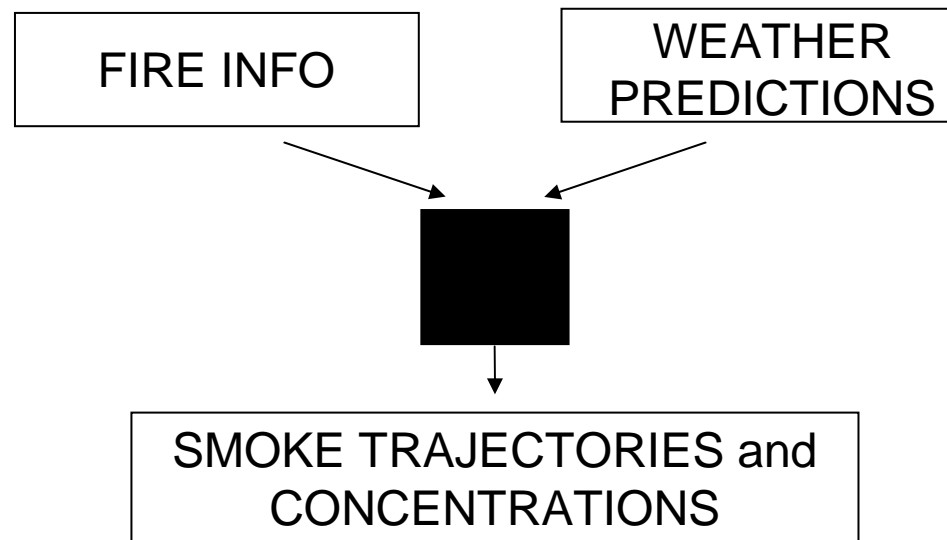
*More health awareness, encroachment (WUI)*

Tightening regulations

*NAAQS standards ( $PM_{2.5}$  &  $O_3$ ), regional haze rule, exceptional events standards*

# There is more we can do - now

Smoke Tools are inherently technology dependent  
*Even more so than weather forecasts*

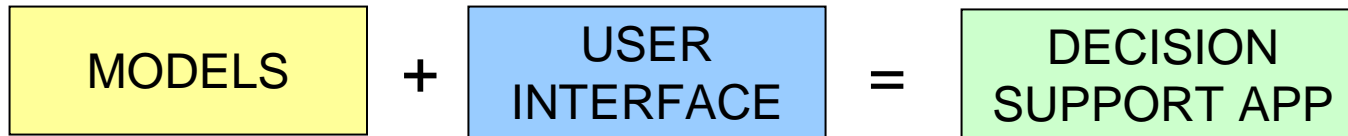


Too technological to be done on desktops/laptops

But technology has advanced massively  
*Now we have the world-wide web*

# The State of Smoke Tools

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## Technology Development Progression

**Emergent**

**Mature**

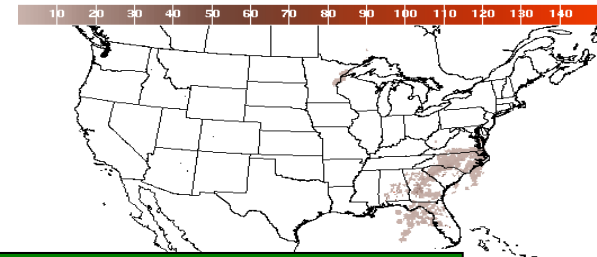
*few,  
'silos',  
confusing*

*user choices,  
inter-operability,  
ease of use*

# National Smoke Products

## National Weather Service

- smoke only (12-km) & aq (36-km)



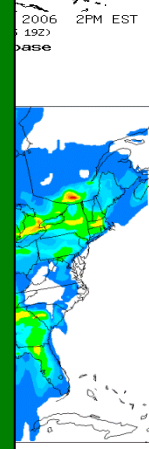
## STI

- 
- 

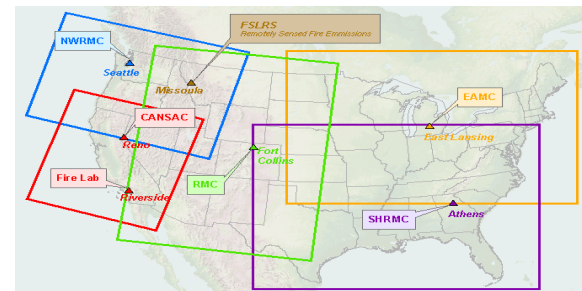
## FCA

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All based on the modular  
BlueSky Smoke Modeling Framework  
developed by the USFS, STI, & partners



- regional hi-res (4-km)
- national 12-km 3-day  
(based on NWS NAM)
- national 36-km 7-day  
(based on NWS GFS)





# Lessons Learned

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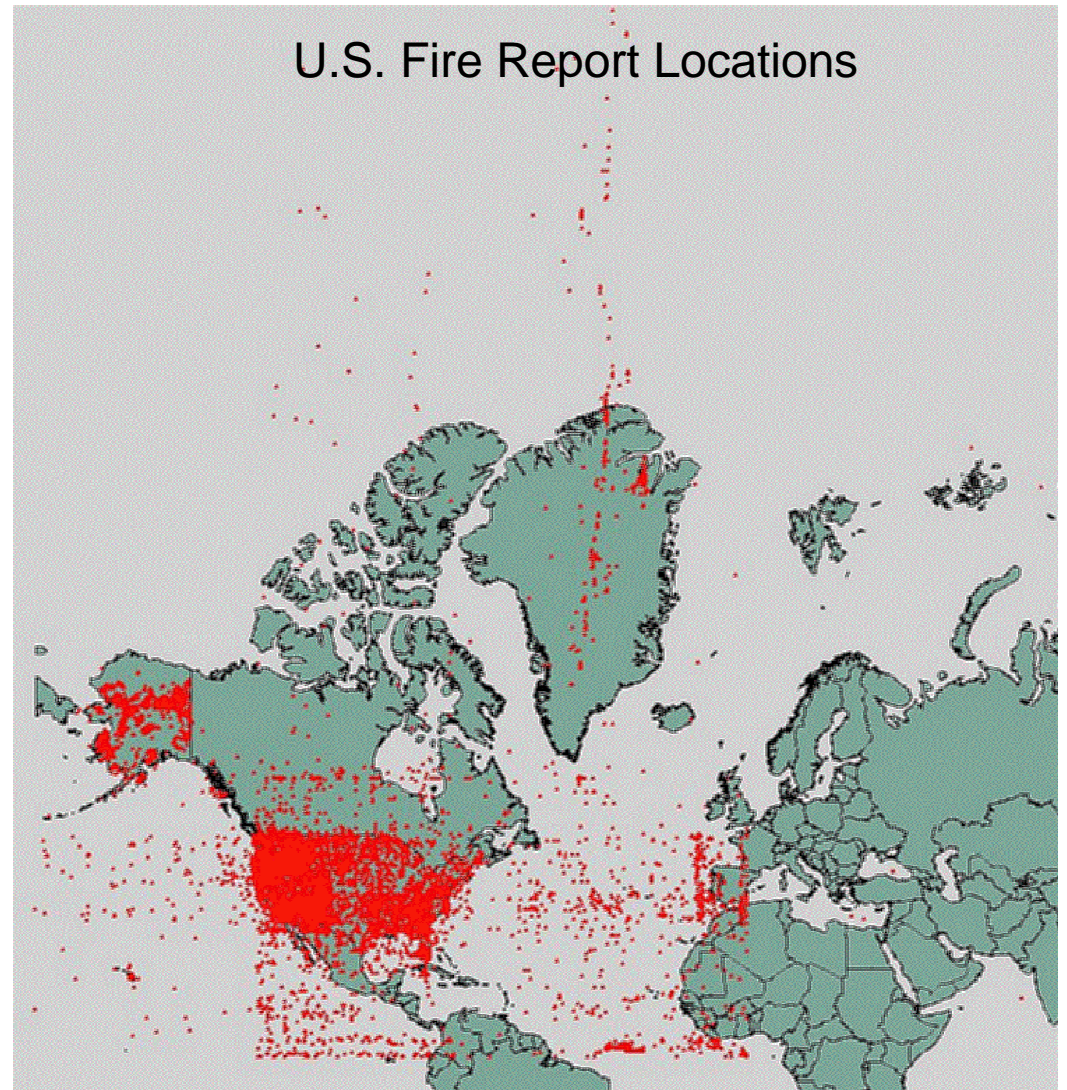
Long-range transport looks good;

Underprediction of ground concentrations

*Fire information is of poor quality*

*Models differ substantially*

*Plume rise needs fixing*

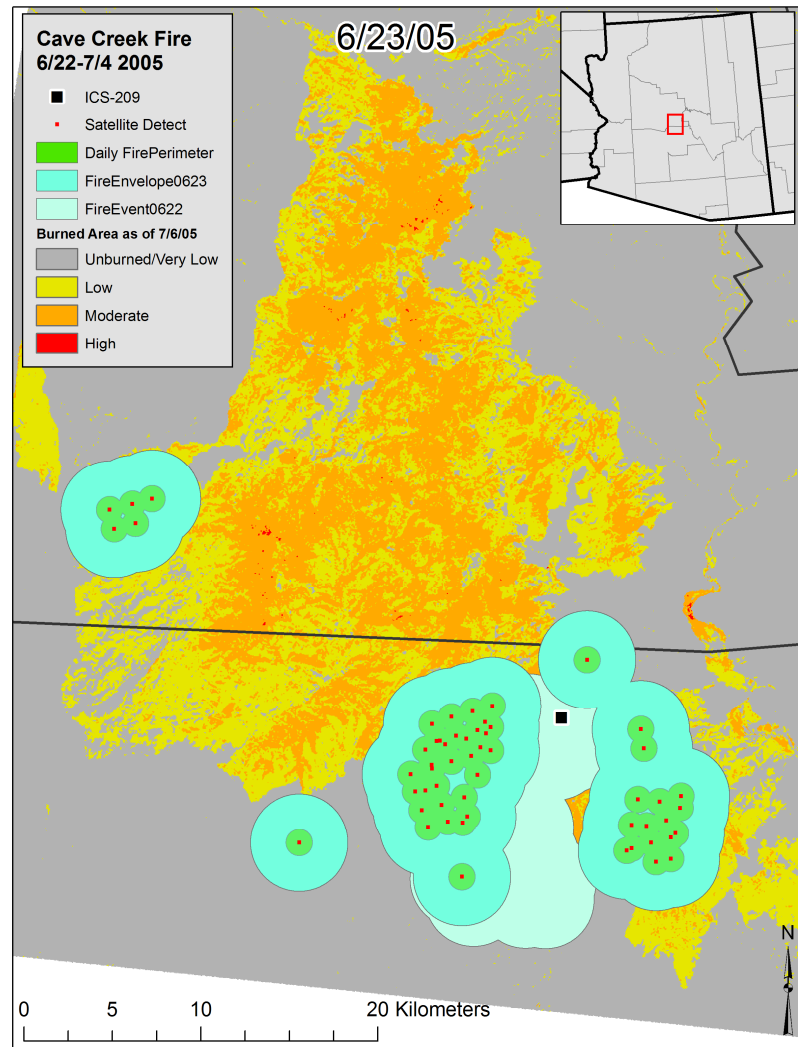




# SMARTFIRE: Reconciled fire data

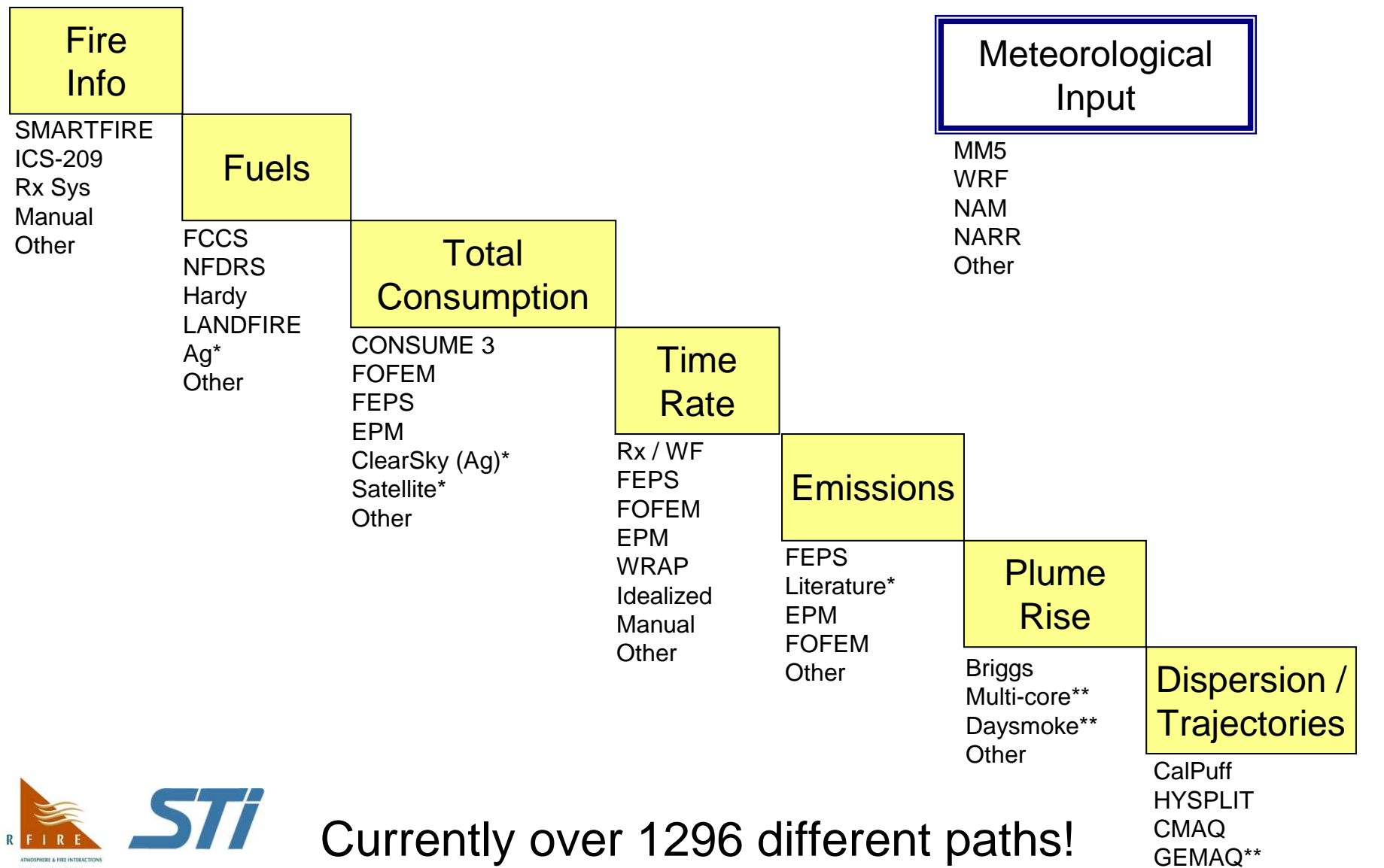
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- Ground reports
- Satellite fire detects (NOAA HMS)
- Expert users (IC Teams)



# The BlueSky Framework:

Logical, Modular Steps from Fire Info to Smoke Impacts

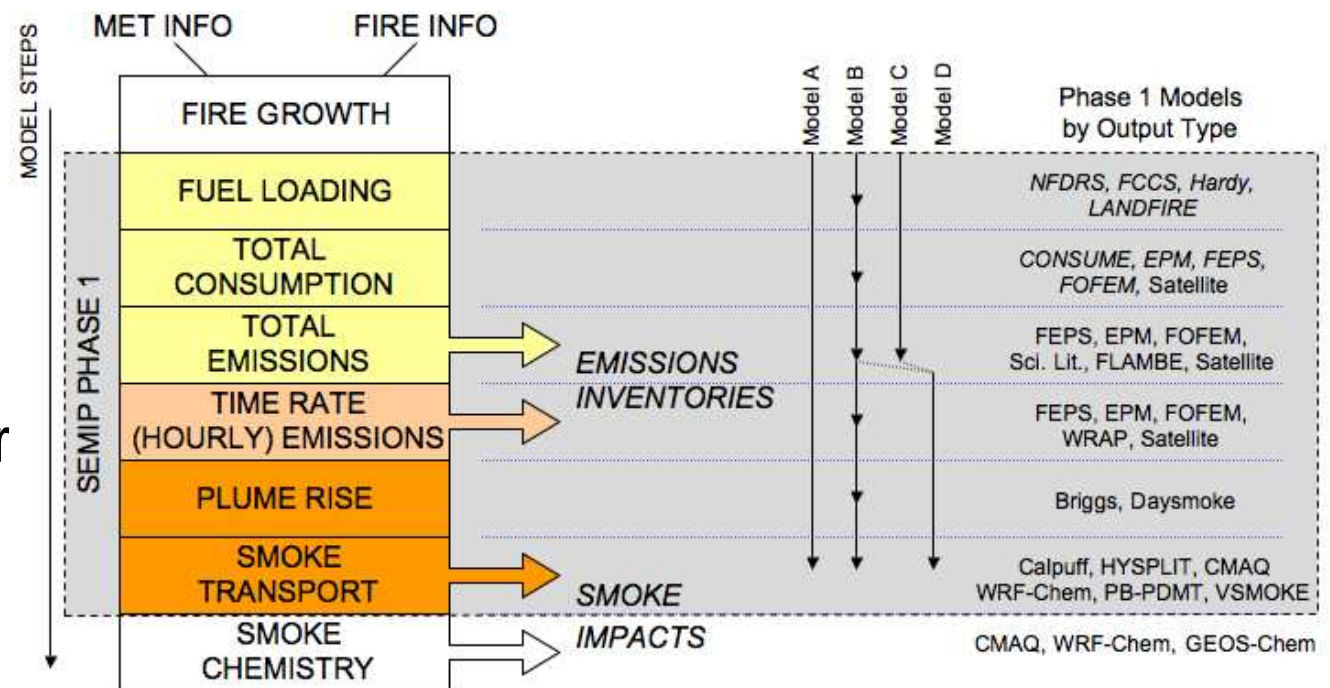


# Smoke and Emissions Model Inter-comparison Project (SEMIP)

Just funded

Large-scale,  
Inclusive

Based on other  
“MIPs”



# Plume Rise

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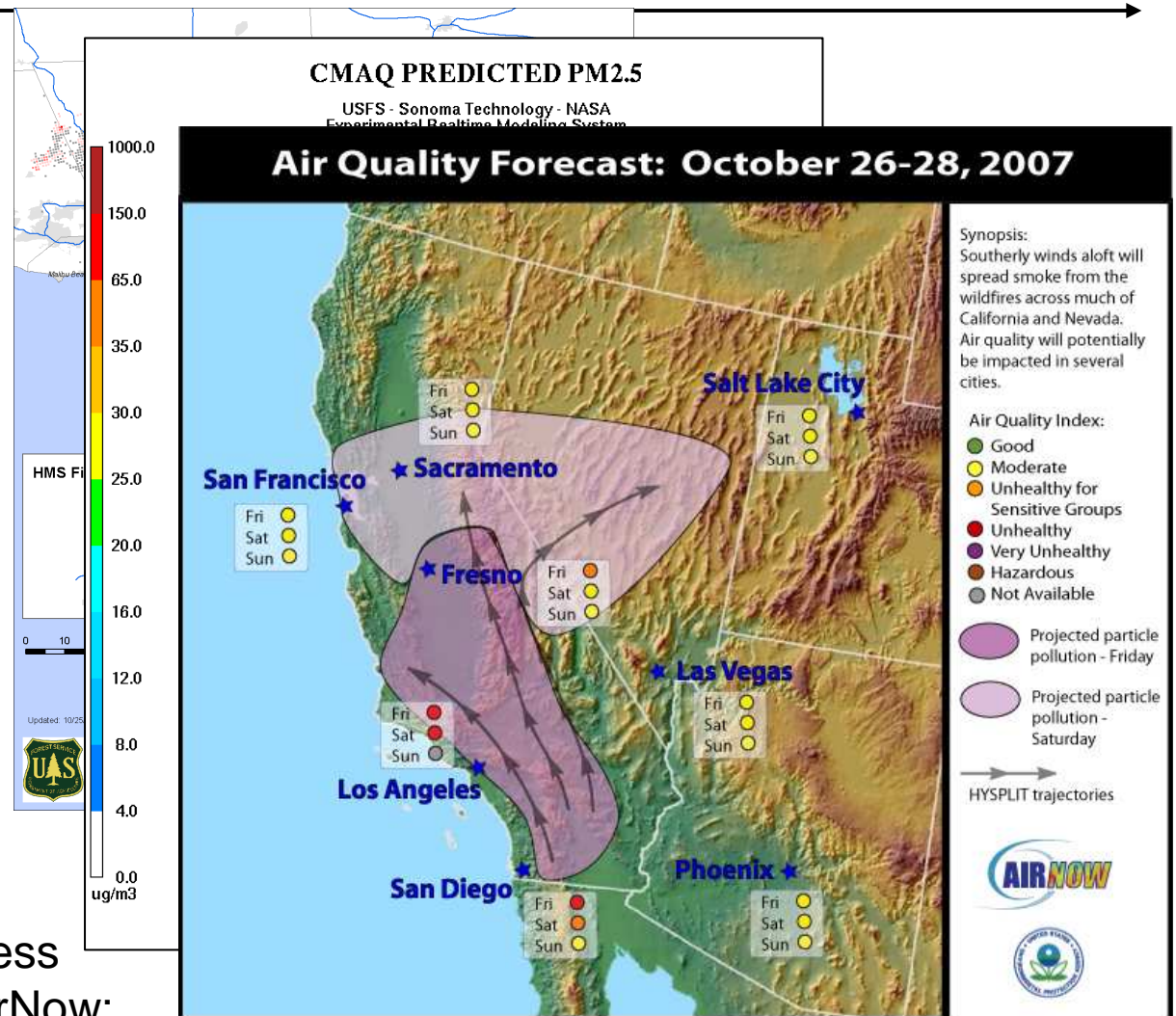
- Fires are currently modeled as single plumes, lofting smoke unrealistically high and lowering ground impacts
- In reality, fires are made of many burning areas lofting smoke to various heights





# Southern California Fires 2007

- asked by USDA for data
- supplemented other sources (e.g. NWS)
- SMARTFIRE (HMS&ICS) fire info
- CMAQ and CALPUFF model outputs
- Used:
  - internally by USFS fire resource managers;
  - in Smog Stories and press releases by USDA & AirNow;
  - on White House conf call



# Northern California Fires 2008

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State of Emergency / Presidential Declaration

Enormous Smoke Impacts (> 5 million people affected)

USFS AirFire Team & Partners (STI, DRI) asked to develop  
prototype ESRS by Region 5

Federal / Private / University partnership

Rapid Response basis



# Emergency Smoke Response System: Experimental Predictions

[home](#)  
[contact us](#)

Forecast

Model Output

Monitoring

## FOCUS:

1. Additional monitoring
2. Higher resolution
3. On-the-fly trajectories
4. Other species (e.g. Ozone)
5. Smoke apportionment by source fire
6. Provide Forecasts

*expert interpreted forecast text and graphics*

# Very High Resolution

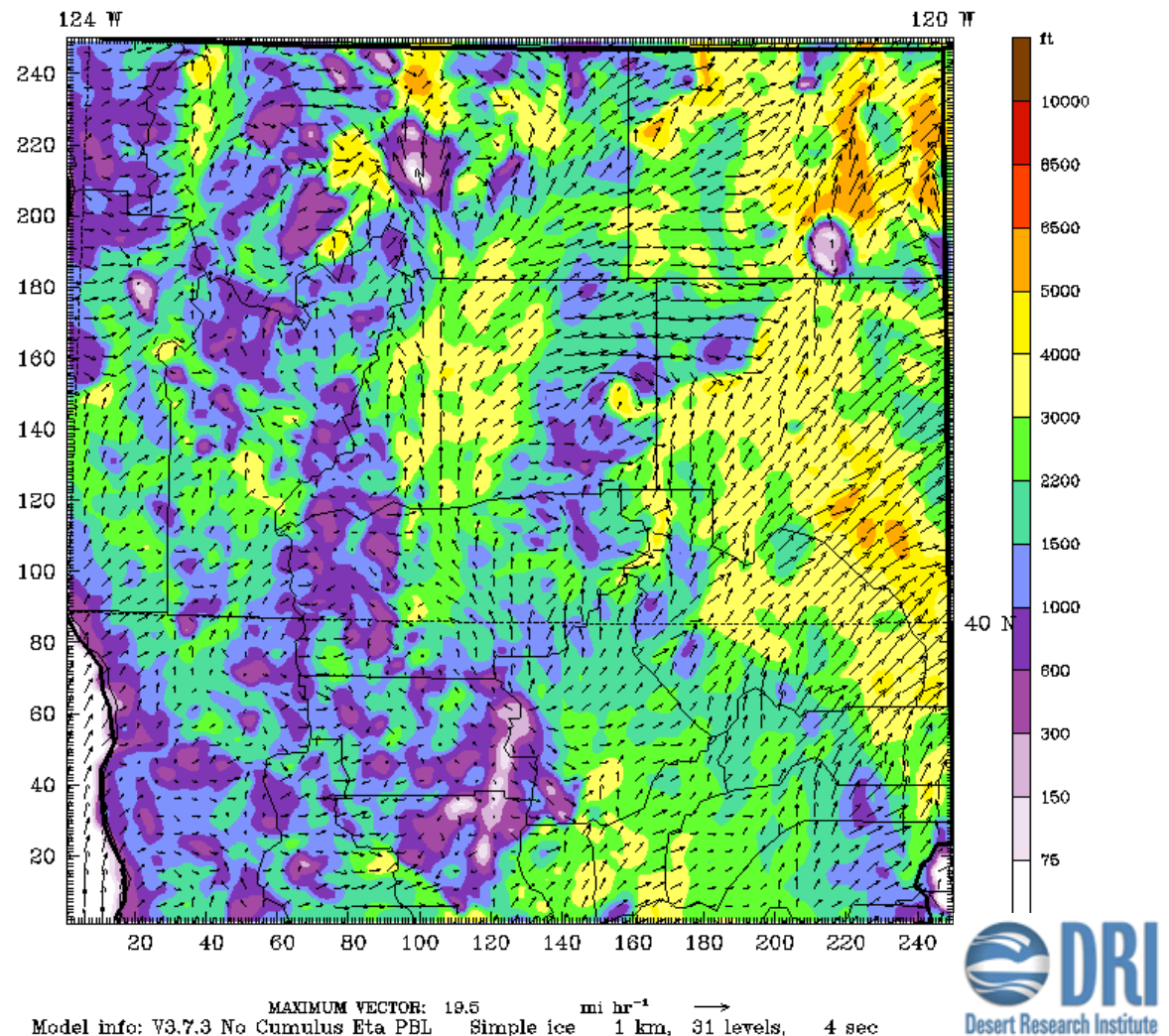
High resolution (1.33 km) meteorology and smoke dispersion

For both fire behavior and air quality

Winds, temperature, RH, mixing height, and smoke  $PM_{2.5}$

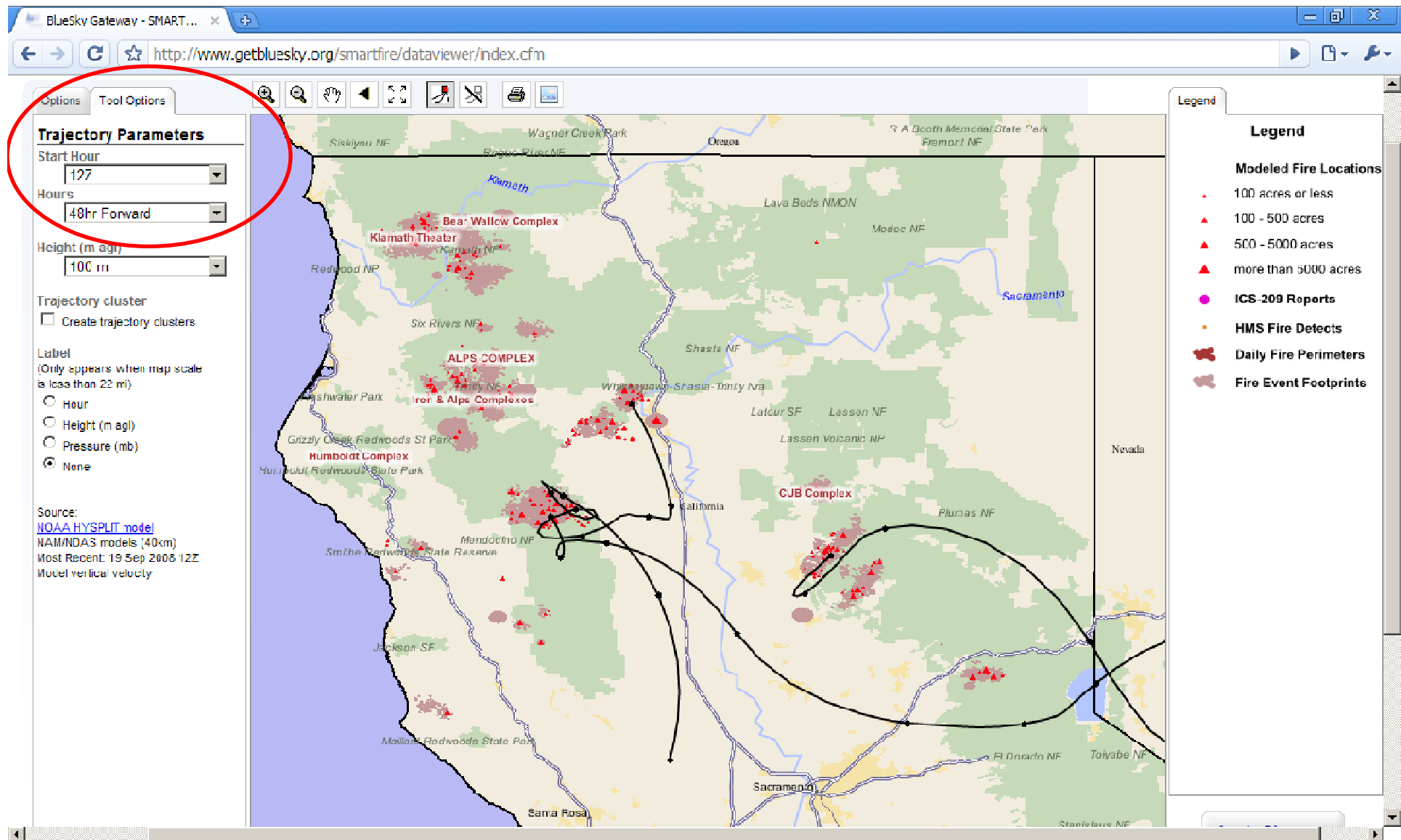
Java animations available online

CANSAC MM5 Realtime: Domain 4 (1.33 km) Init: 0000 UTC Fri 19 Sep 08  
Fest: 24.00 Valid: 0000 UTC Sat 20 Sep 08 (1700 PDT Fri 19 Sep 08)  
Mixing Height sm= 2  
Horizontal wind vectors at height = 0.01 km sm= 1





# On Demand Trajectories



# Ozone (experimental only)

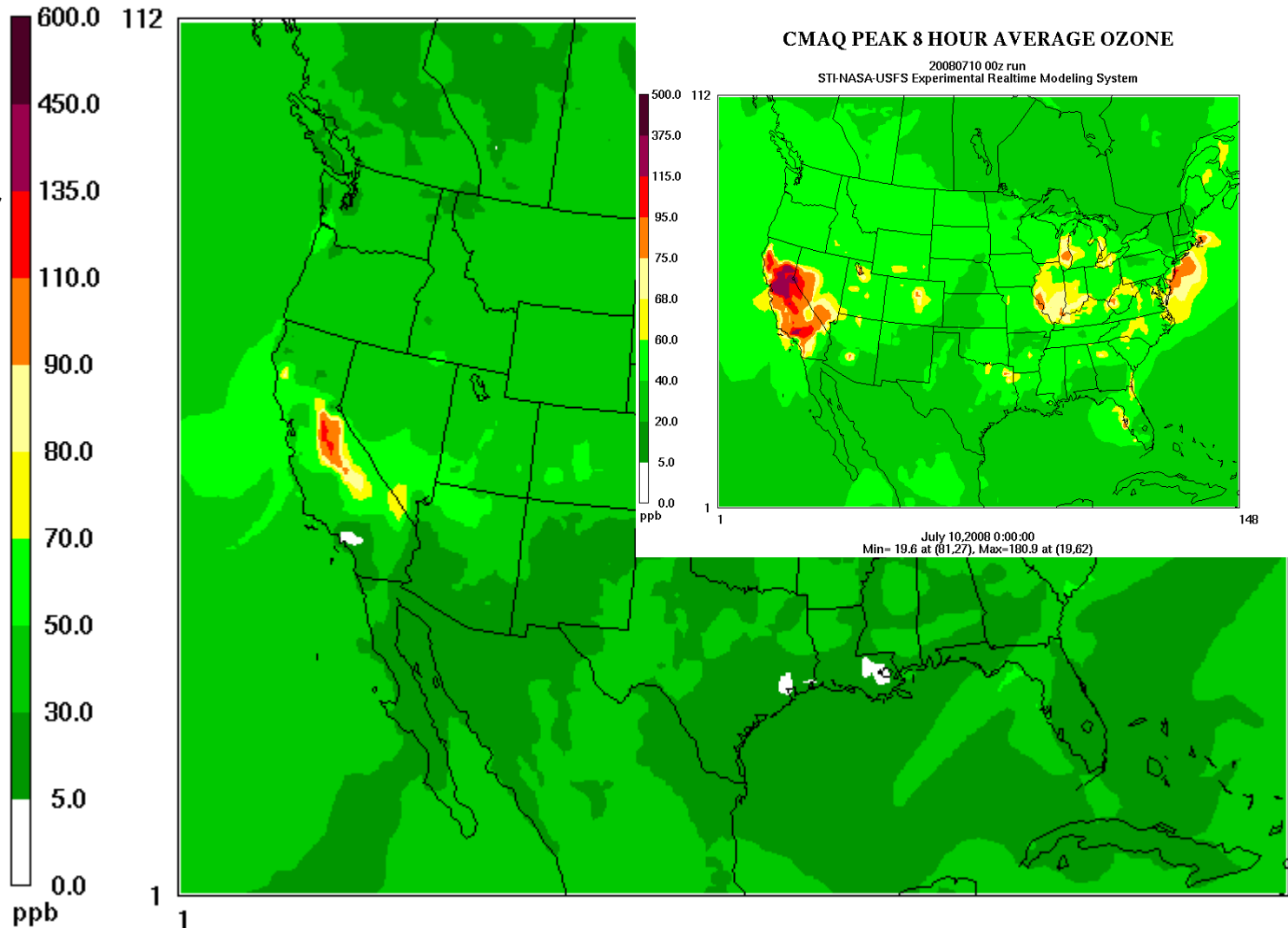
CMAQ OZONE

20080710 00z run

STI-NASA-USFS Experimental Realtime Modeling System

Daily 36-km air  
quality model

Includes fires, other  
sources, and  
photochemistry

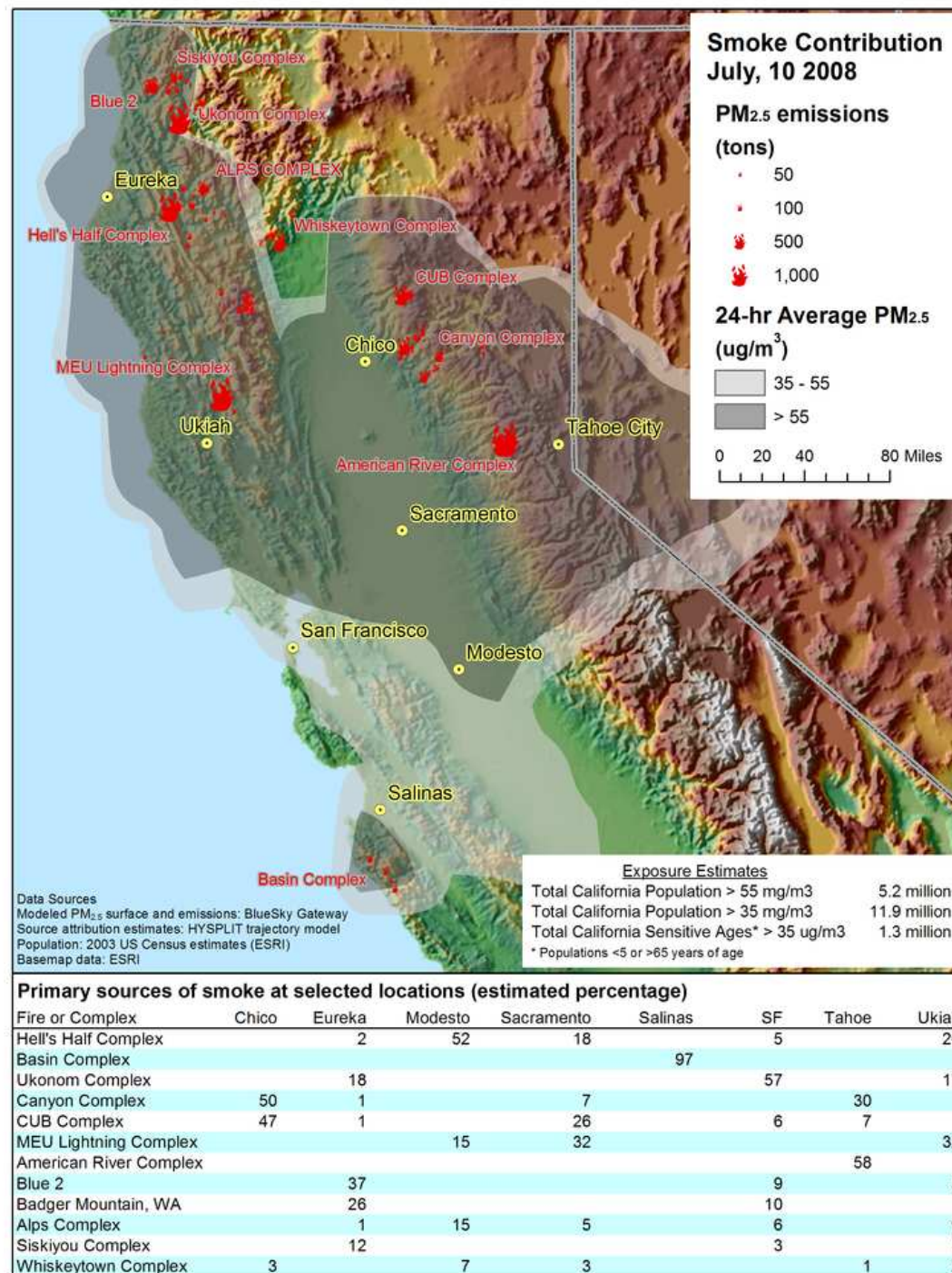
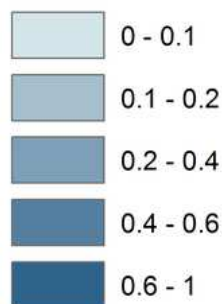


# Smoke Exposure Contribution Map

Combines modeled emissions and transport to determine which fires are likely to contribute to unhealthy air



## Transport Density

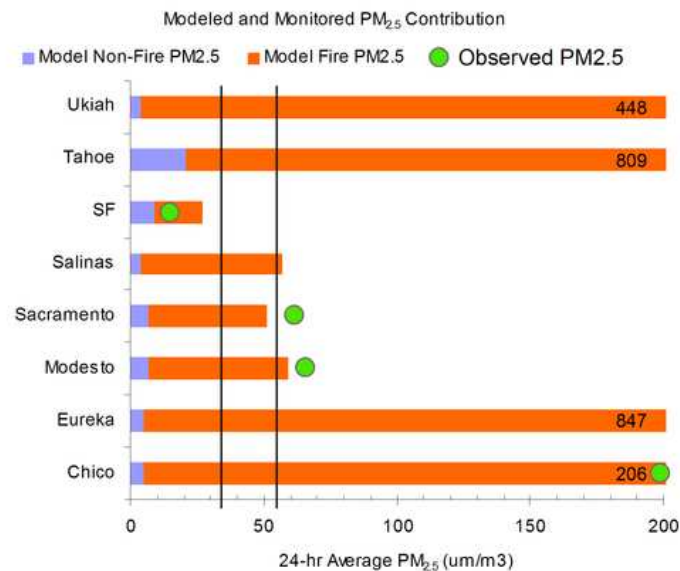


# Exceptional Event Analysis

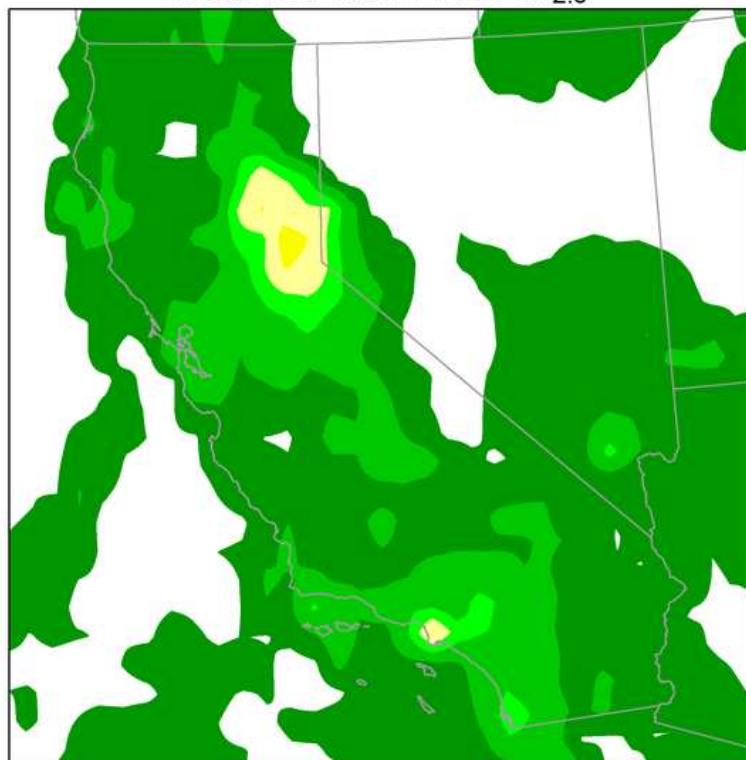
To determine whether National Ambient Air Quality Standard (NAAQS) exceedances are the result of an exceptional event (e.g., one or more large wildfires) it must be shown that the exceedances would not have occurred without the event.  $PM_{2.5}$  is modeled as two separate layers by the BlueSky Gateway Experimental Modeling System, one layer for smoke and one for all other pollution sources.

The modeled 24-hour  $PM_{2.5}$  concentrations from non-fire, fire, and combined sources are shown here. In this case, fire sources dominate. The modeling suggests that none of the analysis cities would have violated the standards if the fires were absent and these exceedances could be argued to be exceptional events.

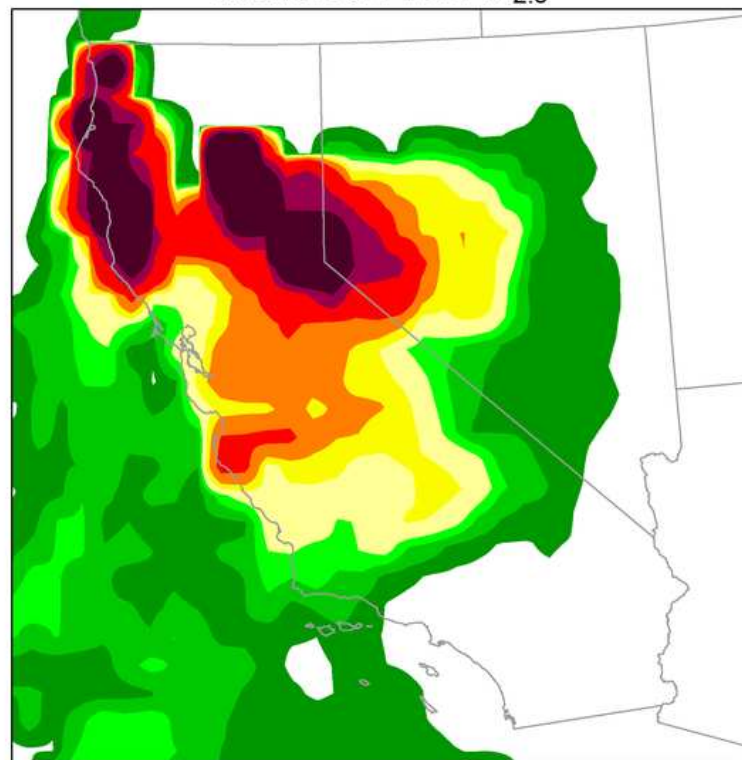
Observed concentrations were also examined to verify the model predictions. Measurements from the AIRNow Program are plotted on the total  $PM_{2.5}$  map and on the graph for analysis cities that had reporting monitors for this date. In this case, the model performed very well.



Modeled Non-Fire  $PM_{2.5}$



Modeled Fire  $PM_{2.5}$





# Northern California Fires 2008

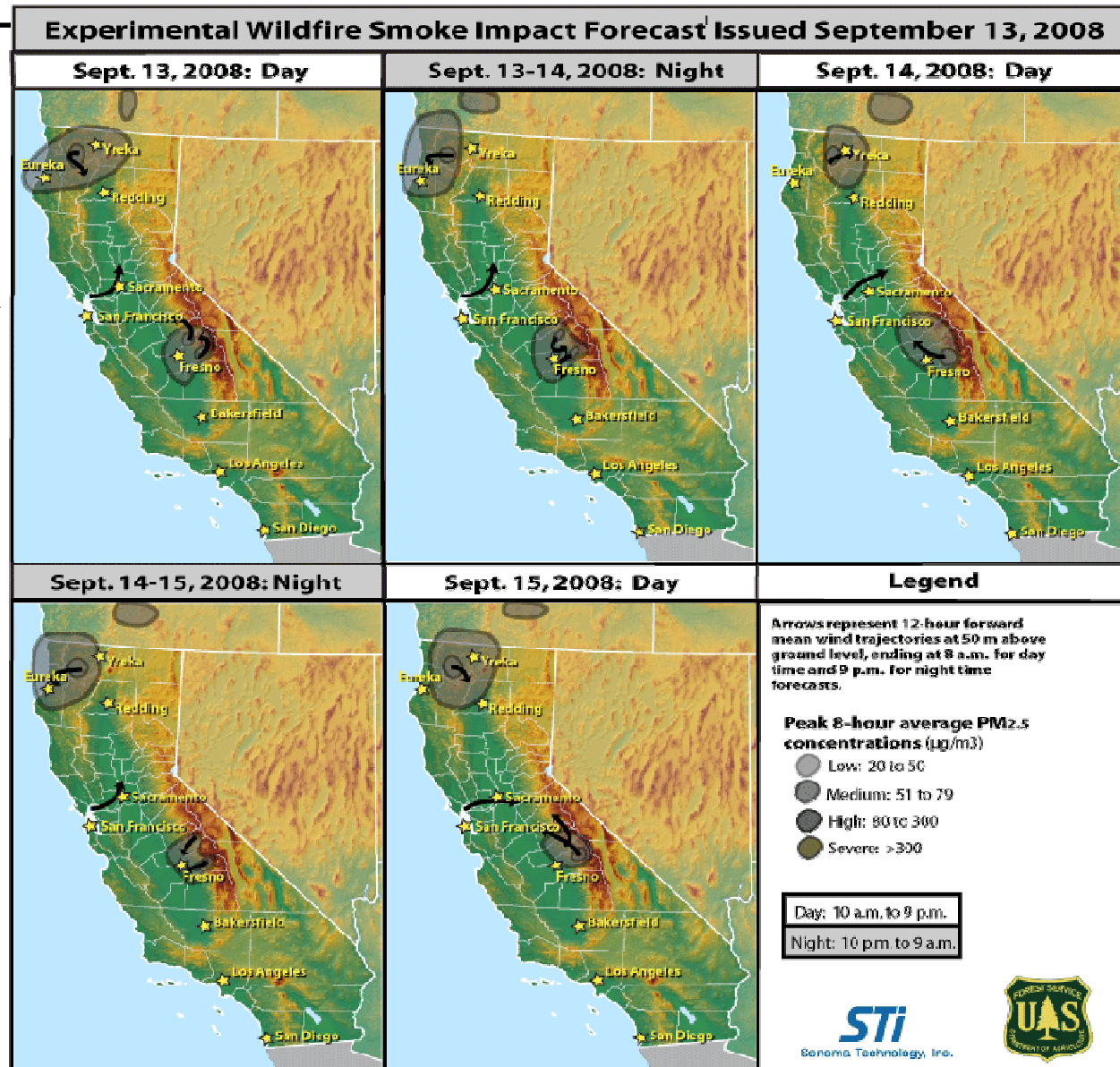
Daily Forecast  
Graphics

3 day, 2 night outlook

Prepared by air  
quality meteorologist

Forecast text  
summary

[http://cefa.dri.edu/  
california](http://cefa.dri.edu/california)



1 This product only includes predicted air quality impacts due to wildfire. For official air quality forecasts, go to [airnow.gov](http://airnow.gov) or check your local air quality district website.

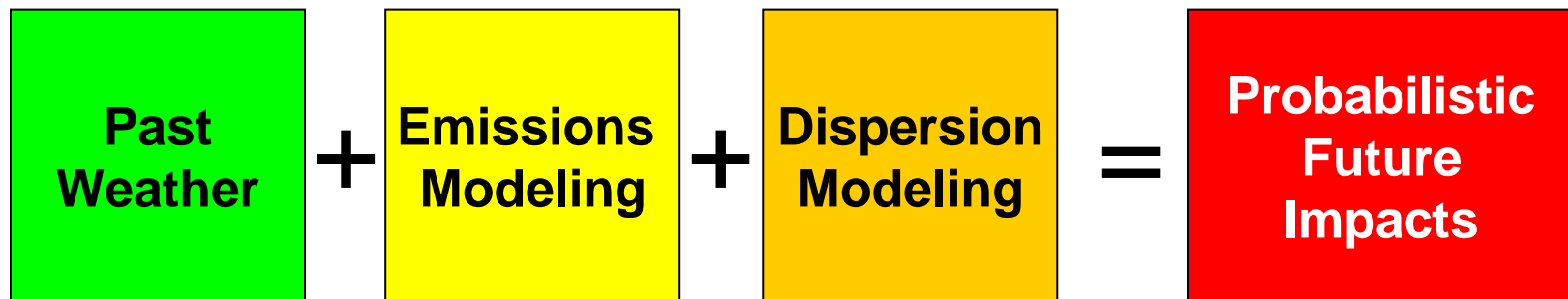
# AQUIPT: Longer-range planning

*air quality impacts planning tool*

Example: planning fire next Spring

Can't say what impacts **will be**

But can use **history as a guide**



Web Interface

# AQUIPT: Accessible through web

*air quality impacts planning tool*

The screenshot shows the AQUIPT web application running in a Mozilla Firefox browser window. The browser's address bar displays the URL `http://localhost:8084/AQUIPT/request.jsp?step=3`. The application's header features the AQUIPT logo and the text "Air Quality Impacts Planning Tool". Below the header, there are navigation tabs: "Submit Request", "Request Status", "Manage Account", and "Admin". A "Logout" link is also present. The main content area is titled "Request Description - Emission Source Characteristics - Analysis Dates - Analysis Options - Confirm", with "Analysis Dates" being the active tab. The "Analysis Dates" section includes a "Month/Day" selector with a radio button for "January" and a date range from "January 1" to "January 31". Below this is a "Year" selector with a radio button for "2005" and a range from "2005" to "2006". The "Apply Weather Criteria Filter" section has a "Yes" button. Below this, there are five rows of weather criteria filters, each with a "Min" and "Max" column. The filters are: Temperature (Min: 9, Max: 11), Relative Humidity (Min: 9, Max: 11), Wind Speed (Min: 9, Max: 11), Wind Direction (Min: 9, Max: 11), and Ventilation Index (Min: 9, Max: 11). Each filter has a dropdown menu for the time of day, with "Morning" selected for all. At the bottom of the form are "Back" and "Next" buttons. The footer of the application displays "AirFIRE Home" and "Forest Service".

AQUIPT - Air Quality Impacts Planning Tool - Mozilla Firefox

File Edit View History Bookmarks Tools Help

`http://localhost:8084/AQUIPT/request.jsp?step=3`

Customize Links Free Hotmail Windows Marketplace Windows Media Windows STI Intranet ColdFusion Upload File FogBugz MySQL JSP, JSP Exam... Stored Procedures in ...

Disable Cookies CSS Forms Images Information Miscellaneous Outline Resize Tools View Source Options

**AQUIPT**  
Air Quality Impacts Planning Tool

— An AirFIRE research project —

Submit Request Request Status Manage Account Admin Logout

Request Description - Emission Source Characteristics - **Analysis Dates** - Analysis Options - Confirm

**Analysis Dates**

Month/Day  
☒ January 1 to January 31  
☐ January February March April

Year  
2005 2004 2003 2002 2006

Apply Weather Criteria Filter: Yes

Min		Max	
9	< Temperature	11	Morning
9	< Relative Humidity	11	Morning
9	< Wind Speed	11	Morning
9	< Wind Direction	11	Morning
9	< Ventilation Index	11	Morning

Back Next

AirFIRE Home - Forest Service

# AQUIPT: Summary

Provides statistical answer to “what would have happened?”

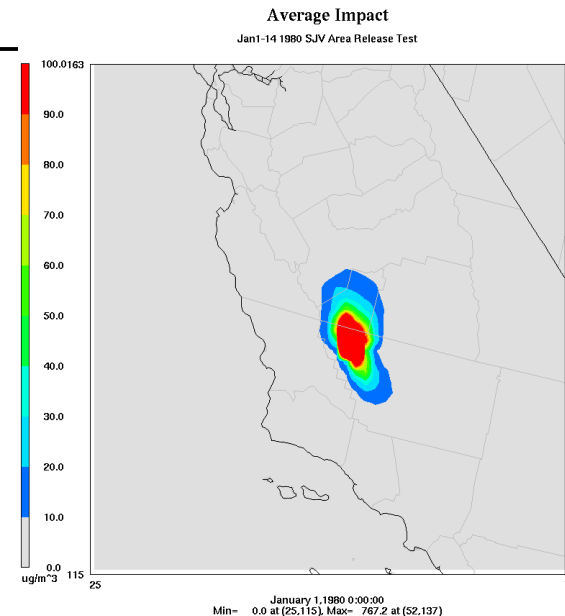
Provide basic source info, it does the rest

Not just fire

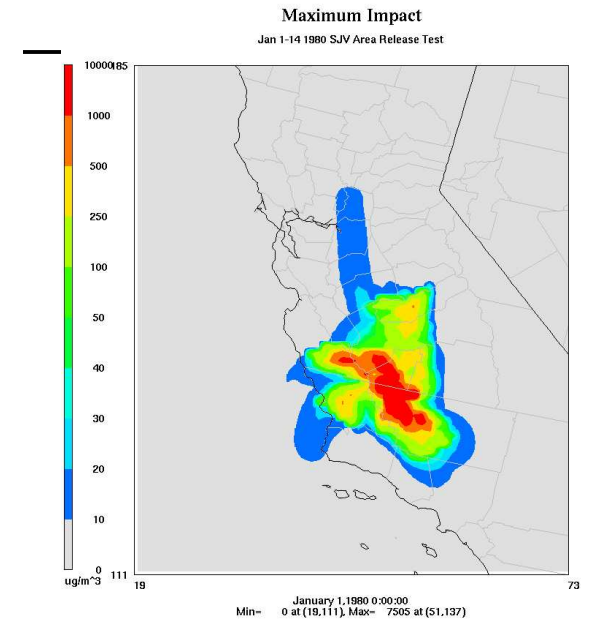
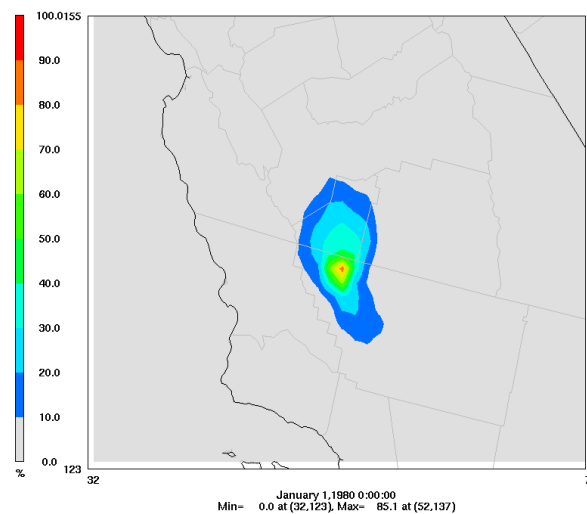
Uses 1979-2006 climatology

24-hr turnaround

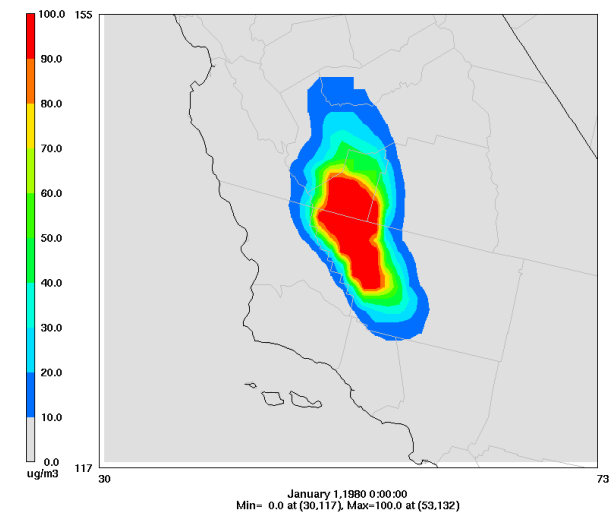
Working on better graphics



35 ug/m<sup>3</sup> Threshold Impact  
Jan 1-14 1980 SJV Area Release Test



Percentage of Time Impact (5% level)  
Jan 1-14 1980 SJV Area Release Test

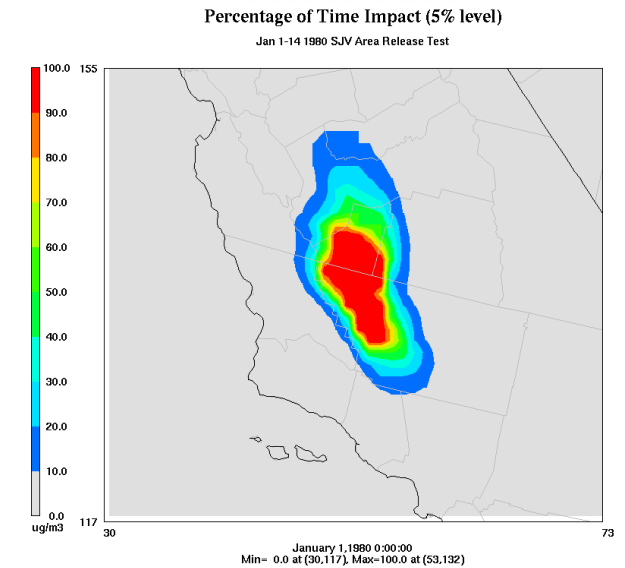
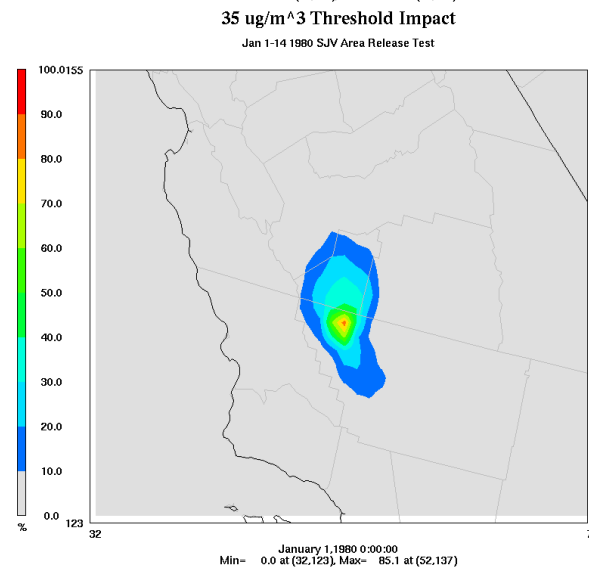
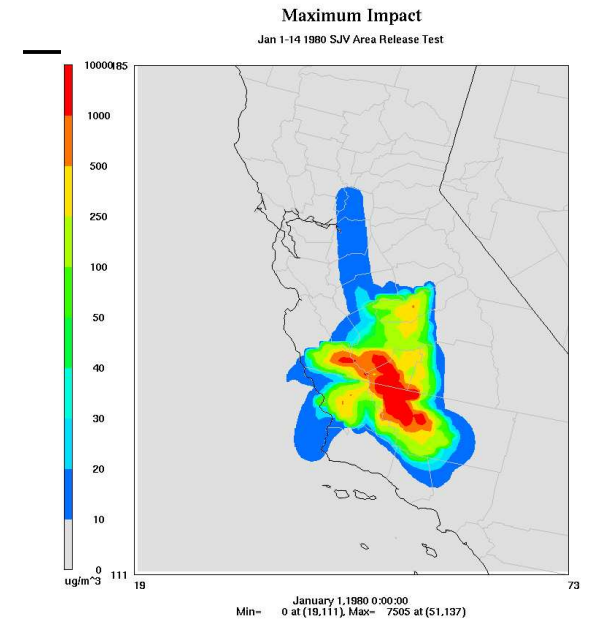
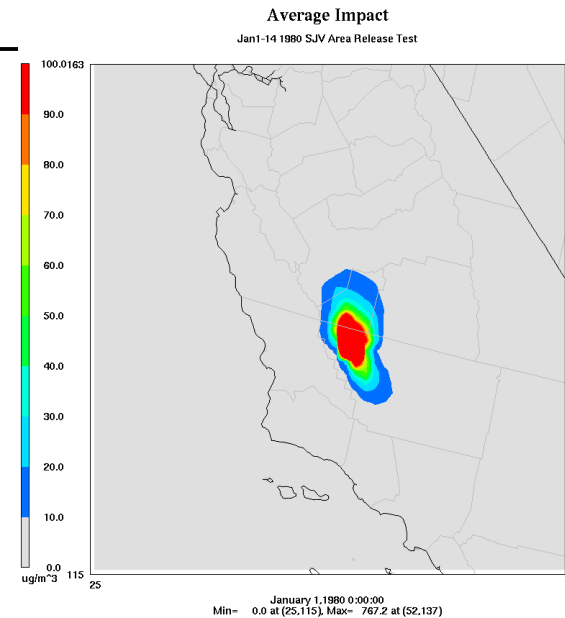




# WFDSS - Smoke Component

Probabilistic smoke impacts to go with FSPRO's probabilistic fire growth

Working w/  
Mark Finney



# Thank you

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Funding from National Fire Plan, USDA CSREES NRI, USFS, Joint Fire Science Program, EPA, DOI, and NASA ROSES DSS.

<http://getBlueSky.org>

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